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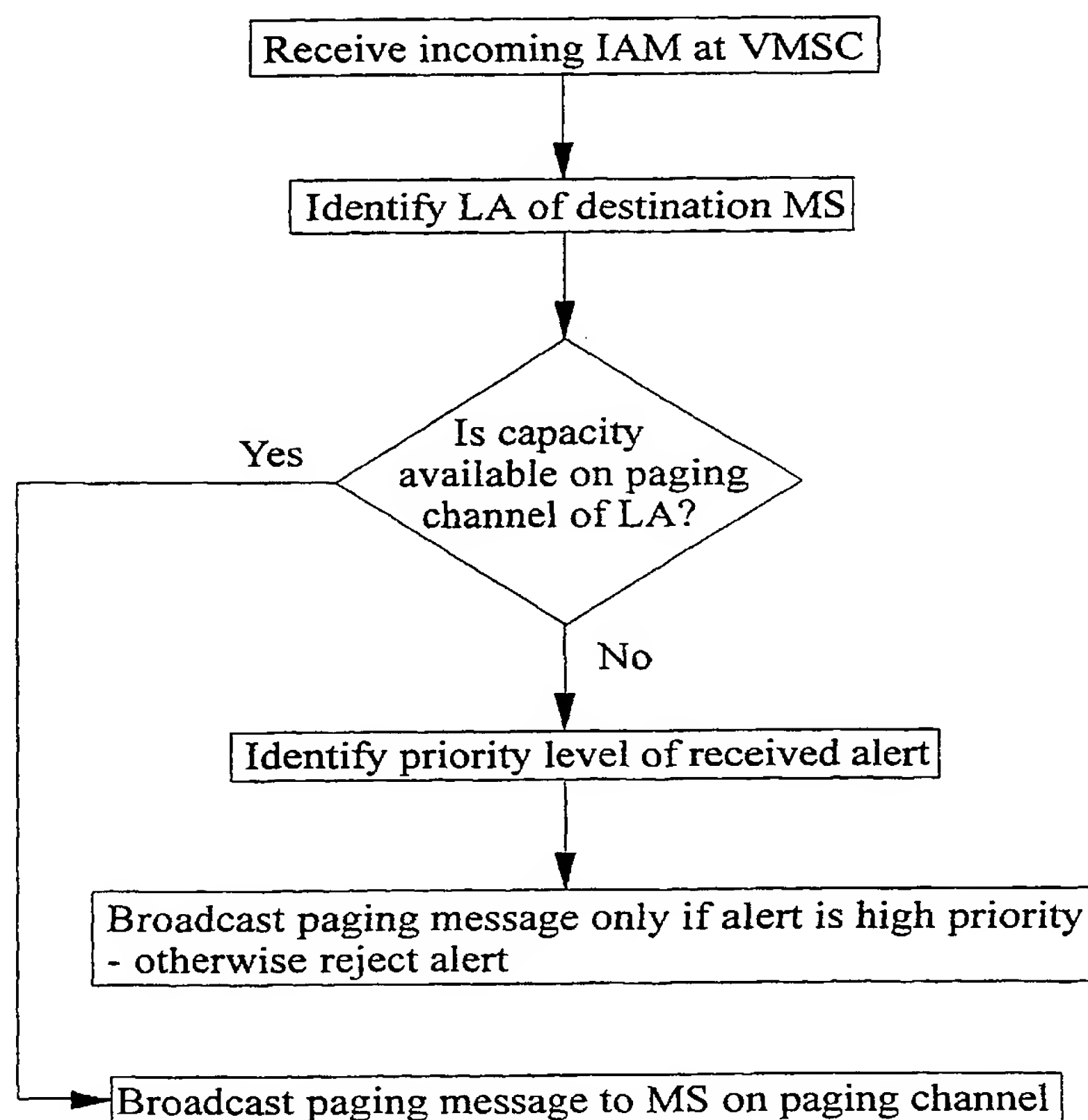
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[Continued on next page]

(54) Title: PAGING IN A MOBILE TELECOMMUNICATIONS NETWORK



(57) Abstract: A method of handling incoming call and message alerts at a control centre of a mobile telecommunications network (1) during periods when the level of incoming alerts is high. The method comprises receiving the alerts at the control centre (7), identifying the priority level of each alert, and broadcasting paging messages corresponding to at least a fraction of the alerts to respective mobile stations (3) registered with the network (1). Paging messages corresponding to those alerts having a high priority level are broadcast ahead of those having a lower priority level.



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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

PAGING IN A MOBILE TELECOMMUNICATIONS NETWORK

Field of the Invention

The present invention relates to paging in a mobile telecommunications network and more particularly to the paging of a mobile station registered with a mobile telecommunications network.

Background to the Invention

In today's mobile telecommunications networks, a mobile stations currently registered with a network is notified of an incoming call by a paging message transmitted from a mobile switching centre (MSC) of the network, via a Base Transceiver Station (BTS), on a broadcast paging channel. A mobile station is similarly notified of incoming text messages (and other network notification messages) by broadcast paging messages.

In a typical digital mobile telecommunications network, BTSs are responsible for communicating with mobile stations within respective geographical cells within which the BTSs are centred. Sets of adjacent BTSs are grouped into respective Location Areas (LA). In the European GSM networks, the BTSs of a given LA are controlled by a Base Station Controller (BSC). A Visitor Location Register (VLR) maintains a record of the mobile stations currently registered with the network, as well as the LA in which each registered mobile station is currently located. This information is updated as mobile stations roam between LAs. Each VLR is typically co-located with a MSC of the network. In the Japanese PDC networks, the role of the BSC is integrated into an MSC referred to as a Visited MSC (VMSC) such that it is the VMSC which maintains and updates LA information.

Considering further networks of the PDC type, a Japanese digital standard, each LA is allocated a single paging channel on which paging messages may be broadcast to mobile stations within that LA. The capacity of a single paging channel in a PDC network is 15 pages per 0.72 seconds. During peak usage times and/or for LAs which encompass a relatively dense population (e.g. where the LA encompasses a sports

stadium or exhibition hall), the capacity offered by a single paging channel may be insufficient. This may result in incoming calls not being connected to mobile stations as well as to delays in the delivery of text and other messages.

A similar paging channel overload may arise following the failure of a VMSC or a component thereof. In a PDC network, such a failure may result in the loss of information which identifies the LA in which mobile stations currently registered with the network are located. This means that upon recovery of the VMSC, it is necessary to page a mobile station, for which an incoming call or message alert has been received, across the entire network (i.e. in each and every LA). This greatly increases the number of paging messages which must be sent in the period following recovery. Again, such a situation may result in incoming calls not being connected to mobile stations as well as to the failure to deliver incoming messages. LA information may also be lost in the event of a failure of a Home Location Register (HLR) of a PDC network, where the HLR maintains details of the location of subscriber's of that network at the MSC level (as opposed to the LA level). Reset of a failed HLR has a knock-on effect on VMSCs which causes loss of LA information at the VMSCs.

Similar problem may arise in mobile telephone networks other than PDC networks, for example in GSM, AMPS, and TACS networks.

Summary of the Invention

It is an object of the present invention to overcome or at least mitigate the above noted disadvantages of existing mobile telecommunications networks and paging systems. This and other objects are achieved at least in part by providing a mechanism by which incoming calls and notifications may be prioritised to ensure the optimal use of paging messages.

According to a first aspect of the present invention there is provided a method of handling incoming call and message alerts at a control centre of a mobile telecommunications network during periods when the paging demand is high, the method comprising:

receiving the alerts at the control centre;
identifying the priority level of each alert; and
causing paging messages corresponding to at least a fraction of the alerts to be broadcast to respective mobile stations registered with the network, wherein paging messages corresponding to those alerts having a high priority level are broadcast ahead of those having a lower priority level.

In certain embodiments of the present invention, the priority level of an alert may depend upon the service to which the alert relates. For example, alerts may relate to voice or fax telephone calls, data calls, text messages, network notification messages, etc. More particularly, the priority level of an alert may relate to the time urgency of the service to which an alert relates. This might mean, for example, that alerts relating to telephone calls are allocated the highest priority whilst alerts relating to text messages are allocated the lowest priority. Thus, in the event that a paging channel is busy, alerts relating to text message deliveries may be rejected whilst alerts relating to incoming telephone calls are processed immediately or are placed in a queue for processing if and when capacity becomes available on the paging channel.

It will be appreciated that the paging messages may be broadcast over a radio interface from a point or points which is/are remote from the control centre. It will also be appreciated that the steps of receiving the alerts and identifying the priority level of each alert may be carried out at one node of the telecommunications network, whilst the step of causing paging messages to be broadcast may be carried out at separate network node.

In other embodiments of the invention, priority is allocated on the basis of the identity of the calling and/or called parties to which an incoming alert is associated. For example, subscribers to a mobile telecommunications network may be able to select one of a number of service levels, the subscriber's tariff being linked to the selected service level. When a paging channel is busy, incoming alerts associated (either as calling party, called party, or a combination of both) with subscribers who have selected the highest priority level will be processed into paging requests ahead of those alerts associated with subscribers who have selected lower service levels.

To identify the priority level of an alert on the basis of calling party identity, the control centre may examine one of:

- the category of the incoming trunk to the centre;
- the phone number series of the calling subscriber; and
- a prefix dialled ahead of the called B-number.

To identify the priority level of an alert on the basis of called party identity, the control centre may examine one of:

- the phone number (B-number) or IMSI number series of the called party; and
- a prefix dialled ahead of the called B-number.

Identification of the priority level associated with a given calling party or called party may be determined by sending an enquiry from the control point to some other network node, e.g. an HLR or an Intelligent Network Service Control Point, where subscriber priority levels are maintained.

The control centre which receives incoming alerts, and causes paging messages to be broadcast, may in a PDC or AMPS network be a VMSC.

In a GSM network, the control centre may be an MSC-VLR or a BSC. In a GSM network, the paging priority may be given by or derived from the enhanced Multi-Level Precedence and Pre-emption (eMLPP) service (ETS 300 932). The BSC may indicate the level of paging congestion in the associated Location Area to the MSC-VLR by sending a paging congestion message to the MSC-VLR. Upon receipt of such a message, the MSC-VLR may filter out low priority alerts, notifying the BSC of only higher priority alerts. In this way, signalling traffic between the MSC-VLR and BSC may be reduced.

In a system where paging functionality is shared between the MSC-VLR and the BSC, in addition to sending a priority level to the BSC together with a paging request, the MSC-VLR may send a queuing indicator. This indicator notifies the BSC of whether or not the BSC may add the paging request to a queue.

The paging priority may depend upon the type of paging which an alert requires. For example, where an alert requires a global page (i.e. a paging over all of the LAs controlled by a control centre), the alert may be given a low priority whilst, where an alert requires a local page (i.e. a paging over a single LA), the alert may be given a high priority.

According to a second aspect of the present invention there is provided paging control system of a mobile telecommunications network, the system comprising:

- input means for receiving alerts corresponding to incoming calls and messages;
- processing means for identifying the priority level of incoming alerts at least during periods when the paging demand is high; and
- transmission means for causing the transmission of paging messages corresponding to alerts over a paging channel of the telecommunications network, the transmission means being arranged to cause the broadcast of paging messages corresponding to alerts having a high priority ahead of those having a lower priority in the event that the volume of incoming alerts is high.

Brief Description of the Drawings

Figure 1 illustrates schematically a telecommunications network of the PDC type; and Figure 2 is a flow diagram illustrating a method of handling paging messages at a VMSC of the network of Figure 1.

Detailed Description of Certain Embodiments

There is shown in Figure 1 a telecommunications network 1 which makes use of the Japanese PDC digital mobile telephone standard. The network comprises a number of Base Transceiver Stations (BTSs) 2, each of which is arranged to communicate with Mobile Stations (MSs) 3 located within a geographical cell 4 upon which the BTS 2 is centred. A set of adjacent BTSs 2, covering an area 5 referred to as a Location Area (LA), are controlled collectively by a Visited Mobile services Switching Centre (VMSC) 7. The VMSC 7 typically controls many LAs and has the role of routing

telephone calls and other user and signalling data within the network 1. In a PDC system, the VMSC 7 maintains a record of those MSs which are currently registered with the network 1 as well as the LAs within which the registered stations are located (in GSM networks, this role is performed by a Visitor Location Register (VLR)).

The mobile network 1 comprises at least one Gateway MSC (GMSC) 8 which provides the interface between the mobile network 1 and foreign networks. Examples of foreign networks are a PSTN network 9 and a mobile network 10.

In the event that a subscriber (to either the PSTN network 9 or the foreign mobile network 10) initiates a voice call to a MS 3 currently registered with the mobile network 1, an Initial Address Message (IAM) is sent using the ISDN User Part (ISUP) protocol from the home network 9 or 10 of the calling party to the VMSC 7 of the mobile network 1. The IAM contains a field which identifies the IAM as relating to a voice telephone call. In normal circumstances, the VMSC 7 will respond to receipt of the IAM by examining its records to identify the current LA of the called MS 3. The VMSC 7 will then cause a paging message to be broadcast, from the BTSs 2 of that identified LA, on the paging channel allocated to the LA.

The broadcast paging message typically includes the International Mobile Subscriber Identity (IMSI) of the called MS 3. The MS 3 listens to the broadcast channel for its own IMSI and responds to the paging message by returning an acknowledgement message to the mobile network 1. Resources over the air interface are thereafter reserved, and a B-number answer message is propagated back to the originating foreign network to establish a circuit switched link for carrying the voice data.

In the event that a text message (referred to as a Short Message Service (SMS) message) is received at the VMSC 7 from, for example, a MS registered either with some foreign mobile network or with the home mobile network 1, the message is first of all transmitted to a Message Centre (MC) 11 of the home network 1. The MC 11 will then send an IAM to the VMSC 7 to alert it to an incoming text message. As with a voice call alert, assuming that capacity is available on the paging channel allocated to the LA in which the destination MS 3 is located, the VMSC 7 will broadcast a paging message

to the destination MS 3. In GSM networks, the alert may be sent from the MC to the MSC-VLR using the MAP message "ForwardSM".

As has already been explained above, it is possible that the volume of incoming alerts may be too high for a single paging channel to handle (either due to sheer demand or possibly following the failure of the VMSC 7 and the loss of location information). The VMSC 7 is aware of the volume of alert traffic (that is incoming IAMs) and in the event of an overload identifies the priority level of each alert. Those alerts which are time-critical are allocated a high priority level while those which are not time-critical are allocated a low priority level. Thus, alerts which correspond to an incoming telephone call for a MS 3 are allocated a high priority whilst those which indicate an incoming text message are allocated a low priority level. The VMSC 7 of the network 1 causes paging messages to be broadcast immediately on the paging channel of the appropriate LA for high priority alerts. In contrast, alerts corresponding to text messages (and other lower priority services) are converted into paging messages only when spare capacity on the paging channel is available and there are no time-critical related alerts waiting at the VMSC 7. In some circumstances, if a paging message cannot be broadcast for a low priority alert, then the VMSC 7 may return an error message to the source, e.g. the MC 11. The source may try to initiate the connection at a later time or may even reject the operation.

It will be appreciated that other types of alerts may be given a high or a low priority level or may be given some intermediate priority level. These include fax call and data call alerts, as well as alerts relating to a Message Waiting Indication (MWI).

In an alternative embodiment of the invention, the operator of a network may require subscribers to select one of a number of service levels. For example, subscribers may select a high priority delivery service or a low priority delivery service. In circumstances where paging traffic is high, subscribers selecting the high priority delivery service will have their outgoing calls paged ahead of those subscribers selecting the low priority service. The operator may of course add a cost premium for the high priority delivery service and/or provide a cost reduction to those subscribers selecting the low priority service. In the event that a call is initiated, or text message

sent, to a subscriber of a foreign network, the IAM may contain an indication of the selected delivery priority which is detected by the foreign VMSC.

The VMSC 7 of the network 1 where a call or text message delivery is initiated, may maintain a register of subscribers together with the selected delivery service. The calling subscriber priority may be determined based upon the category of the incoming trunk to the exchange or the phone number of the calling subscriber. The priority may also be identified on the basis of a number prefixed to the called party's number (B-number). The priority for the calling party may also be determined from an incoming signalling message, e.g. an ISUP signalling parameter.

It will also be appreciated that the delivery service level may be based upon the identity of the called party. The called party category may be derived from the HLR or an SCP or from the phone or IMSI number series of the called subscriber.

As has already been explained, the invention may be applied to GSM networks in which an MSC-VLR generates paging requests based upon incoming alerts, and forwards these to a BSC associated with a given Location Area. In the absence of any knowledge of the level of paging congestion at the BSC, the MSC-VLR must send all paging requests to the BSC. In order to reduce the level of signalling traffic between the MSC-VLR and the BSC, a new parameter may be added to the BSSAP which handles this traffic. This parameter indicates the congestion level at the BSC, and more particularly notifies the MSC-VLR when the paging channel of the BSC is congested. The MSC-VLR thereafter filters out those alerts which have a low priority, and notifies the BSC of only those paging requests corresponding to alerts having a high priority.

In GSM networks, an additional parameter referred to here as a 'queuing indicator' may accompany a paging request sent from a MSC-VLR to a BSC. This indicator indicates to the BSC whether or not the paging request may be placed in a paging queue at the BSC, awaiting broadcast on the paging channel. If the paging channel is congested when a new paging request is received at the BSC, the accompanying queuing indicator is examined to determine whether or not the paging request can be added to the queue. If so, then the request is queued. If the request cannot be queued, then the BSC

analyses the priority level accompanying the request. If the priority level is high, then the BSC may reject a low priority request at or near the front of the paging queue, and replace it with the new request. If the priority of the newly received request is low, then it may be rejected without adding it to the queue. These queuing indicators may be an addition to the use of a paging channel congestion parameter as described in the preceding paragraph.

It will be appreciated by the person of skill in the art that various modifications may be made to the above described embodiment without departing from the scope of the present invention. For example, it has been pointed out that the invention may be applied to a GSM network. In this case, the priority of an alert may be determined at the MSC-VLR level, or at the SCP level. A paging message, together with the priority of the message, is then sent to the appropriate BSC. The BSC is aware of the available paging capacity and is thus able to determine if the paging message should be broadcast.

It will also be appreciated that whilst the above described embodiments utilise circuit-switched calls, the invention may be usefully employed in packet switched networks such as GPRS and the proposed UMTS. The invention is also not limited to the protocols mentioned above for carrying alerts to the VMSC/MSC-VLR. For example, TCP/IP may be used to carry alerts.

Claims

1. A method of handling incoming call and message alerts at a control centre of a mobile telecommunications network during periods when paging demand is high, the method comprising:
 - receiving the alerts at the control centre;
 - identifying the priority level of each alert; and
 - causing paging messages corresponding to at least a fraction of the alerts to be broadcast to respective mobile stations registered with the network, wherein paging messages corresponding to those alerts having a high priority level are broadcast ahead of those having a lower priority level.
2. A method according to claim 1, wherein the priority level of an alert depends upon the service to which the alert relates.
3. A method according to claim 1 or 2, wherein the priority level accorded to a service depends upon the time-criticality of the service.
4. A method according to claim 2 or 3, wherein the services include voice, data, or fax calls and text messages, the latter being given a relatively low delivery priority and the former being given a relatively high delivery priority.
5. A method according to claim 1, wherein priority level is allocated on the basis of the identity of the calling and/or called parties to which an incoming alert is associated.
6. A method according to claim 1, wherein the priority level accorded to an alert depends upon the amount of the paging resources which the alert will occupy.
7. A method according to claim 6, wherein an alert which will result in a global page is given a low priority whilst an alert which will result in a local page is given a high priority.

8. A method according to any one of the preceding claims, wherein the network is a PDC network and the control centre which receives incoming alerts, and causes paging messages to be broadcast, is a VMSC.
9. A method according to any one claims 1 to 7, wherein the network is a GSM network and the control centre which receives incoming alerts, and causes paging messages to be broadcast, is an MSC-VLR or a BSC.
10. A method according to claim 9, wherein the BSC indicates the level of paging congestion in the associated Location Area to the MSC-VLR by sending a paging congestion message to the MSC-VLR, whereupon the MSC-VLR filters out low priority alerts, notifying the BSC of only higher priority alerts.
11. A method according to claim 9 or 10, wherein the MSC-VLR sends a queuing indicator to the BSC together with a paging request for the BSC to broadcast a paging message, the queuing indicator notifying the BSC of whether or not the BSC may add the paging request to a queue.
12. A method according to any one of claims 1 to 7, wherein the control centre is a Service Control Point.
13. A paging control system of a mobile telecommunications network, the system comprising:
 - input means for receiving alerts corresponding to incoming calls and messages;
 - processing means for identifying the priority level of incoming alerts at least during periods when the paging demand is high; and
 - transmission means for causing the transmission of paging messages corresponding to alerts over a paging channel of the telecommunications network, the transmission means being arranged to cause the broadcast of paging messages corresponding to alerts having a high priority ahead of those having a lower priority in the event that the volume of incoming alerts is high.

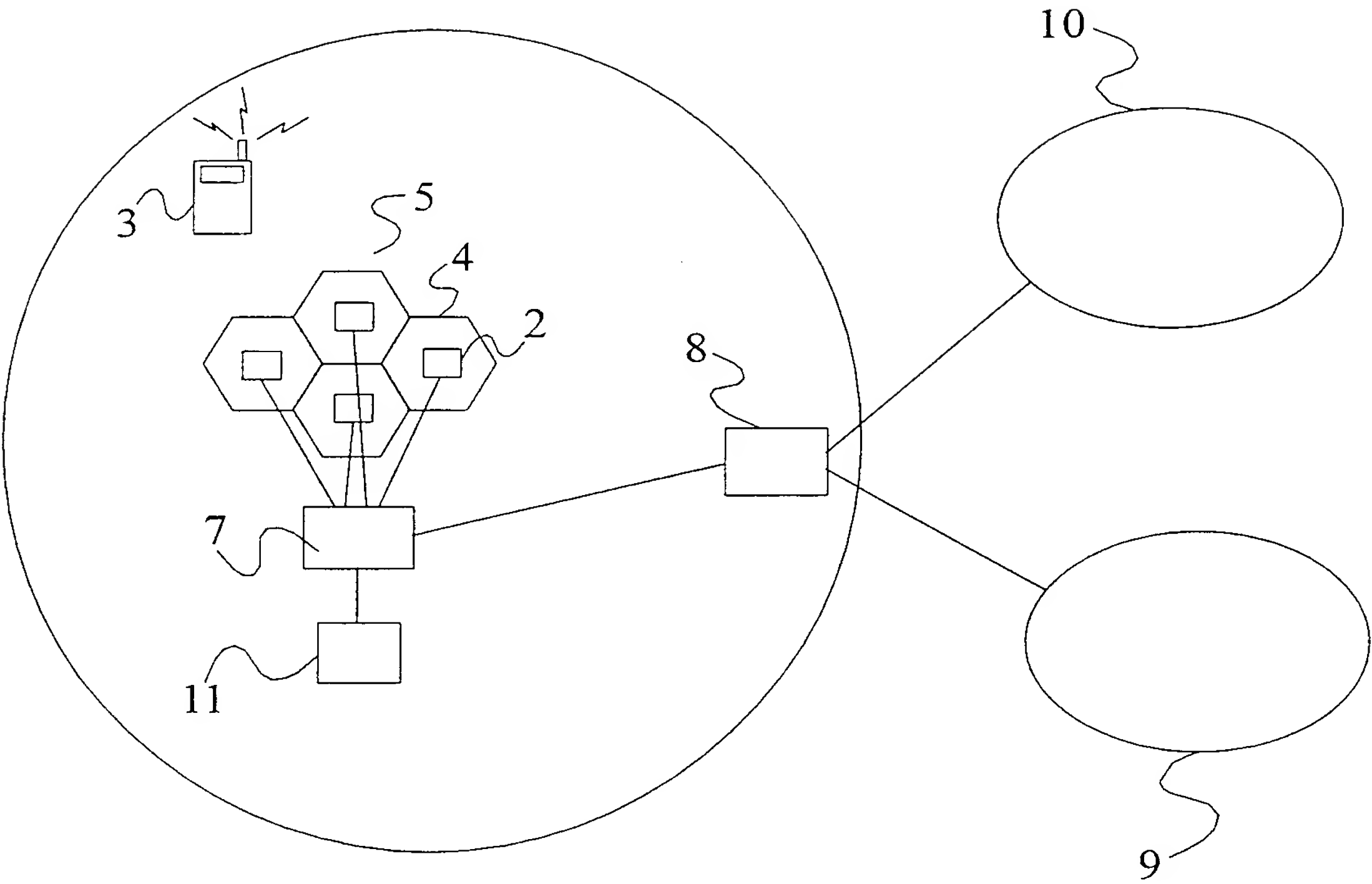
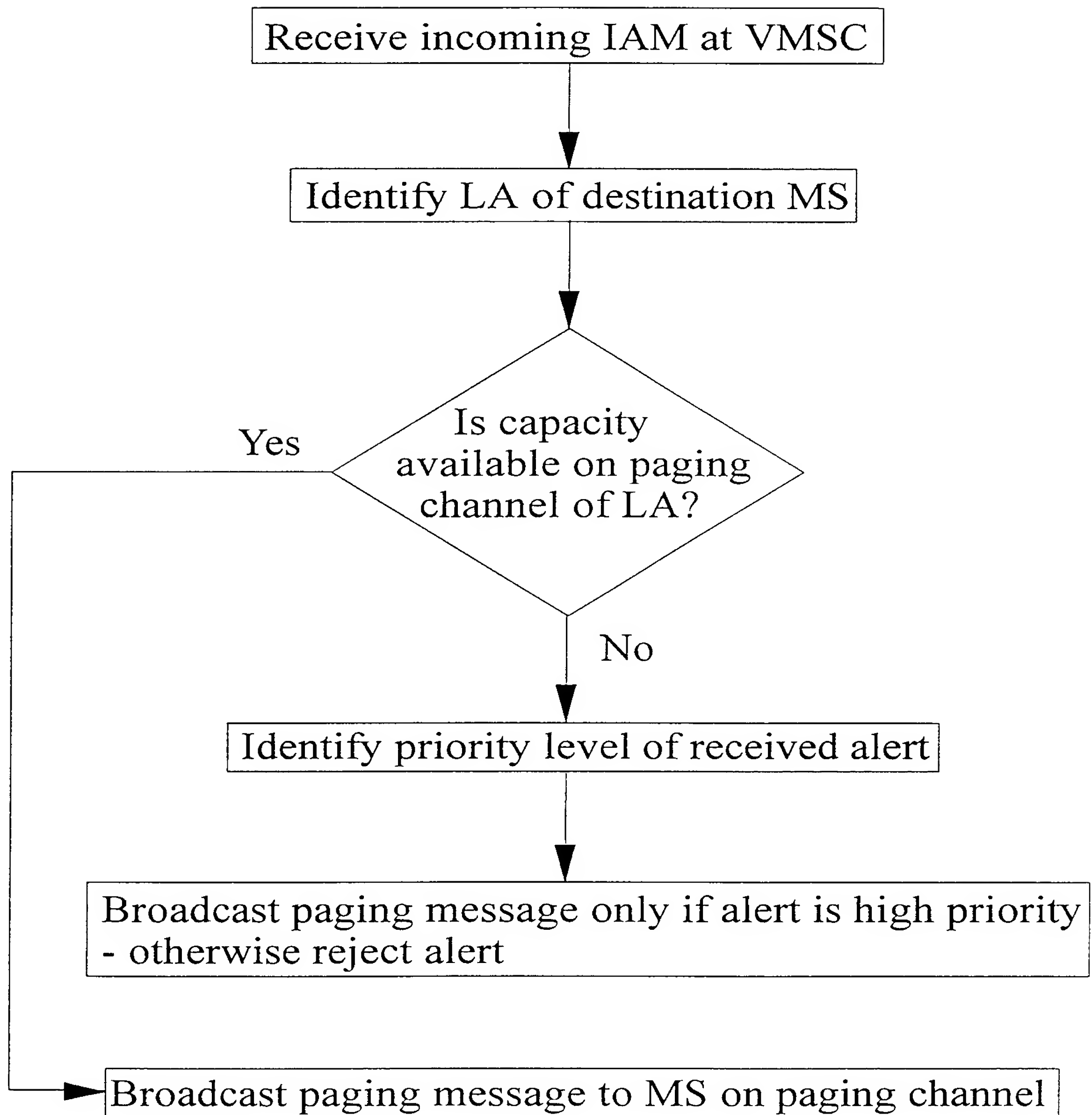


Fig 1

2/2

Fig 2

INTERNATIONAL SEARCH REPORT

International application No.

PCT/EP 00/04228

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: H04Q 7/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Y	WO 9716931 A1 (MOTOROLA INC.), 9 May 1997 (09.05.97), page 6, line 4 - line 27; page 7, line 20 - line 32; page 8, line 1 - line 11, page 10, line 20 - line 30; abstract	2-3,9-10
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☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/EP 00/04228

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	WO 9920073 A1 (ERICSSON INC.), 22 April 1999 (22.04.99), abstract -- -----	1-13

SA 2607

INTERNATIONAL SEARCH REPORT

Information on patent family members

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International application No.

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